Chapter 2
The Characteristics of Small Country National Innovation Systems

Tõnu Roolaht

The need for a systemic approach to innovation processes was already highlighted in the 1980s. This was based on the understanding that the majority of the new knowledge required for innovations does not originate from universities or from other research institutions, but from a much wider circle of sources that include consumers, suppliers, engineers, and others (see, e.g., Lundvall et al. 2002: 215). This posed the challenge to merge these various creators of new knowledge as well as their relationships – networks – into a holistic approach. This idea was realized in the concept of a national system of innovation introduced in separate works by Freeman (1982) and Lundvall (1985). The systemic approach to innovation processes was well received and approaches to innovation systems on different levels soon emerged: regional (Cooke 1992), sectoral (Breschi and Malerba 1997) and technological (Carlsson and Stankiewicz 1991; Carlsson 1995). These innovation systems on various levels have received considerable research attention in the last decade (see, e.g., literature reviews by Carlsson 2003 or by Naubahar 2006).

However, Niosi (2002) argued that refining the systemic approach to innovation has been difficult due to the lack of a single universally approved approach to defining national innovation systems and the ambiguous use of several key terms. In response, Edquist (2005) expressed the need for theoretically founded empirical work in the field in order to advance the concepts toward becoming theory.

This call for empirical contributions toward the formation of a theory resulted in the monograph *Small country innovation systems: Globalization, change and policy in Asia and Europe* edited by Edquist and Hommen (2008). In this book, the authors compare several national innovation systems from Asia (Taiwan, Singapore, Hong Kong, South Korea) and Europe (Sweden, Finland, Norway, Ireland, the Netherlands). Among them, Netherlands, Taiwan, and South Korea have populations ranging from 16 to 49 million people. Thus, the title is somewhat arbitrary and the term

T. Roolaht (✉)
Faculty of Economics and Business Administration, University of Tartu, Tartu, Estonia
e-mail: tonu.roolaht@mtk.ut.ee

E.G. Carayannis et al. (eds.), *Innovation Systems in Small Catching-Up Economies*, Innovation, Technology, and Knowledge Management 15,
DOI 10.1007/978-1-4614-1548-0_2,

small country interpreted rather loosely. Still, this contribution offers important insights into the contextualization of smaller innovation systems as opposed to the large-scale systems in countries like the USA and Germany.

A small country or economy is usually defined by its economic size, whereas the population and the gross domestic product (GDP) are commonly used key indicators (Forsyth 1990). The differences in population size are proxies for differences in market sizes, different scales of indigenous industries, and different scopes of specialization as well as differences in aggregate levels of savings and investments (ibid.). Paas (2009) indicates geographic area as yet another indicator of smallness. All three indicators – population, geographic area, and GDP – relate to the size of the economy in terms of its fundamental resources – human, land, and capital. These measures can also be combined into indices, which might render more balanced estimates, but add complexity and are not as easily understood as single figures (ibid.).

According to Forsyth (1990), there is a growing consensus among international organizations and development bodies as well as among development economists and planners that a population of five million is a limit below which the economy and institutions tend to be severely constrained and some national institutions, infrastructural arrangements, and services may become uneconomic.

Nevertheless, the population thresholds used in different studies vary considerably, being sometimes as low as just 1.5 million or as high as 10 million (Paas 2009). Salvatore (2001) even makes a distinction between extremely small (population less than 1 million), very small (between 1 and 5 million) and small (from 5 to 16 million) economies. Thus, the choice of a particular threshold for the population indicator in order to define economies as small remains arbitrary. Yet, the smaller a country is, the more likely it is to have specific features characteristic to small countries. Therefore, a country with 16 million people might not exhibit all the limitations commonly attributed to small economies.

The general level of GDP is also a reasonable indicator for evaluating the size of the economy. However, in most situations it would be reasonable to adjust this figure in order to account for the differences in purchasing power. GDP *per capita* is a useful tool for differentiating between economies on various development levels. This is an important addition to the population data because certain disadvantages of smallness can be overcome by the high development level of the economy. Countries such as Kuwait and Singapore are small in terms of population, but belong to a group of high-income economies (as indicated using GDP *per capita*). This allows them to take advantage of the benefits of being small, such as certain flexibilities, while offering better opportunities to build support frameworks for innovation and for economic development in general. The reverse situations occur as well, where the population might be quite large, but income levels are so low that the economy faces several limitations of smallness (Paas 2009; Forsyth 1990).

Table 2.1 offers a selection of small economies together with the population- and GDP-based estimates of size and gross domestic expenditure on R&D. As can be seen from these illustrative figures, there is considerable diversity among small economies in terms of economic development (indicated by GDP per capita) and in commitment to innovation (indicated by R&D expenditure), while size on the basis on population does not seem to determine development.

Table 2.1 Population, GDP, and R&D expenditures in selected small economies

Country	Population – 2007 (millions)	GDP – 2007 (PPP US$ billions)	GDP per capita – 2007 (US$)	Gross domestic expenditure on R&D – 2008 (% of GDP)
Iceland	0.3	11.1	64,190	2.65
Malta	0.4	9.4	18,203	0.54
Luxembourg	0.5	38.2	103,042	1.62
Montenegro	0.6	7.0	5,804	–
Cyprus	0.9	21.2	24,895	0.47
Qatar	1.1	56.3	64,193 (2006)	–
Estonia	1.3	27.3	15,578	1.29
Gabon	1.4	20.2	8,696	–
Guinea-Bissau	1.5	0.8	211	–
Gambia	1.6	2.1	377	–
Botswana	1.9	25.6	6,544	–
Slovenia	2.0	54.0	23,379	1.66
Namibia	2.1	10.7	3,372	–
Latvia	2.3	37.3	11,930	0.61
Mongolia	2.6	8.4	1,507	0.26 (2005)
Jamaica	2.7	16.3	4,272	0.1 (2007)
Kuwait	2.9	121.1 (2006)	42,102	0.2
Albania	3.1	22.4	3,405	–
Armenia	3.1	17.1	3,059	0.21 (2005)
Uruguay	3.3	37.3	6,960	0.4 (2007)
Panama	3.3	38.1	5,833	0.25 (2005)
Lithuania	3.4	59.3	11,356	0.8
Congo	3.6	13.2	2,030	0.48 (2007)
Liberia	3.6	1.3	198	–
Moldova	3.7	9.7	1,156	0.53 (2007)
New Zealand	4.2	115.6	32,086	1.3 (2007)
Ireland	4.4	194.8	59,324	1.43
Croatia	4.4	71.1	11,559	0.9
Georgia	4.4	20.5	2,313	0.18 (2005)
Singapore	4.5	228.1	35,163	2.6 (2007)
Costa Rica	4.5	48.4	5,887	0.4 (2007)
Norway	4.7	251.6	82,480	1.62
Turkmenistan	5.0	22.6	2,606	–
Finland	5.3	182.6	46,261	3.72

Source: Human Development Reports 2007/2008 (2007), 2009 (2010), and Eurostat (2010)

In this chapter we use population as the main indicator of size, while GDP *per capita* reflects differences in development level. The countries with a population around five million are the focus of our interest as small. However, some examples, such as countries with a population around ten million (e.g., Portugal) are included as well. This helps to outline the complexity of interplay between population size and GDP *per capita.*

Geographic area as an indicator is not used because due to variations in geography actual economically usable areas might differ considerably despite seemingly comparable surface areas. This indicator is also likely to have more impact on logistics and transport than on innovation systems and on innovation intensities.

Unlike GDP-based estimates, gross domestic expenditure on R&D is not an estimate of country size. It is used here solely as a proxy for a country's commitment to innovation. Thus, it conveys not an approximation of the size of a country, but the country's dedication to innovation via investments in formal R&D.

Smallness can also be defined in relative terms; for example, in the context of larger EU Member States, like France, Germany, Italy, Spain, and the UK, which contribute 8–17% of the EU population and 8–20% of its GDP. The same indicators for smaller EU countries (including Cyprus, Estonia, Latvia, Luxembourg Malta, and Slovenia) are below 0.5% per country. These are the relative extremes. Several other countries contribute less than 3% each to the total population and GDP of the EU (Paas 2009).

Thus, it would be possible to apply various percentage thresholds in order to differentiate between small, medium, and large countries in relative terms. This logic is not inherently characteristic to the EU; it is applicable even in global terms (e.g., the percentage of contribution to global GDP). The preference for a definition of smallness in conventional absolute terms or in relative terms depends often on the aims of each particular research.

Table 2.2 provides the ranking of selected countries according to the global innovation scoreboard analysis provided by Pro Inno Europe. The figures show that some small economies are indeed the leaders of innovation in the world, or at least among the 20 most innovative economies. Others, like the Baltic economies and the Balkan countries, are still in positions that are more moderate.

The innovativeness of an economy could be seen as one indication of a successfully functioning national innovation system. Especially in the case of small countries, innovativeness is a result of clearly prioritizing the development of new technological and business solutions. This means that scarce human and financial resources are organized in a fashion that facilitates the achievement of superior results. Therefore, more innovative small economies are likely to have better national innovation systems or perhaps also better involvement in supra-national regional innovation systems. The general innovativeness of an economy is rarely a stochastic occurrence, although some exceptions are possible.

Due to the partially ongoing economic transition process in some European and neighboring regions, there is also a considerable research gap concerning the specific nature and problems of small-scale systems that experience rapid adjustment processes. The Baltic countries (including Estonia) and some other new EU Member States that joined in 2004 are in certain respects even now influenced by the path-dependent institutional and infrastructural problems rooted in the socialist development era. In this chapter, we will address several characteristics of small economies, some of which also relate directly to their development level. The selection of characteristics is based on the analysis of dominant themes in the literature.

Table 2.2 Global Innovation Scoreboard ranks of selected small countries in 2005

Country	Global innovation scoreboard (general rank)	Firm activities	Human resources	Infrastructure and absorptive capacities
Finland	3	5	1	2
Singapore	12	15	10	10
Norway	15	20	14	5
Luxembourg	19	11	21	–
New Zealand	22	23	26	20
Ireland	23	21	16	23
Slovenia	25	22	28	25
Estonia	28	33	27	27
Lithuania	32	41	30	29
Croatia	35	–	36	43
Cyprus	36	42	37	33
Malta	39	29	47	–
Latvia	47	37	43	40

Source: Pro Inno Europe (2010)
Firm activities include triadic patents per population (3 years average) and business R&D (BERD) as a % of GDP, and account for 40% of the total score; *Human Resources* include S&T tertiary enrolment ratio, labor force with tertiary education (% total labor force), R&D personnel per population, scientific articles per population, and account for 30% of the total score; *Infrastructures and Absorptive Capacity* include ICT expenditures per capita, broadband penetration per population, public R&D (HERD + GERD) as a % of GDP, and account for 30% of total score

It is important to stress that this analysis is not so much aimed at outlining the differences between large and small national innovation systems, as on determining the characteristics. In some cases this might mean the discussion of misconceptions concerning small economies and their innovation systems. The distinction from larger systems also remains relevant.

2.1 Regional and Cultural Disparities in Small Countries

It is a commonly held view that small countries tend to have smaller regional disparities than their larger counterparts. This conclusion is often derived by merely considering the size aspect measured in terms of geographic area, population, and/or the magnitude of the economy. Felsenstein and Portnov (2005) show, however, that this is not necessarily the case. They include several important mediators in the discussion. These constitute a series of spatial and nonspatial factors such as distance, density, factor mobility, natural resources, land supply, social cohesion, and governance structure. With the considerable influence of these mediators the regional disparities in some small countries might be not as small as one would predict on the basis of size alone.

Nischalke and Schöllmann (2005) provide further evidence of the disparities in regional innovation systems even in a small remote country using the example of

New Zealand. They stress the importance of the institutional setup in regions, the need to tailor initiatives to different regional contexts, and the complex relationship between regional development and regional innovation policy despite the smallness of the country.

The more general perspective presented by Nath and Schroeder (2007) on the basis of data from Mauritania supports a certain superiority of local government over central government in providing local services despite the very small size of the country. Their result is robust even when the central government is modeled as the provider of nonuniform customized local services to recognize a spatial variation in preferences. Thus, regional and local levels in small economies should not be disregarded in favor of uniform national-level systems, and the impact of regional disparities should not be excluded from policy considerations in small economies.

The study of Elenkov and Kirova (2008) illustrates, despite the research focus on international business, that small economies can be culturally diverse as well. Such cultural diversities, like the two distinct communities in Cyprus, influence not only human resource management in international business, but also innovative attitudes and activities.

The cultural diversity in a small country might to some extent help to compensate for its smallness by offering some positive synergies. Because the innovation process itself is diverse and dynamic from the fuzzy front end to the systemic monitoring procedures in the market introduction phase, the holistic view might even favor the collaboration of various cultures. However, the crucial element in managing cultural diversity is the potential for conflict. When cultural values are at stake, it is a difficult task to fine-tune in order to retain the complementary collaborative atmosphere and contain conflicting interests. Some conflict can be useful, but long-lasting value conflicts usually draw attention away from development, and in a worst case scenario, might prove fatal. In a small country, cultural diversity might feature even more prominently than in larger countries because the populations are small and likely to feel some anxiety about the sustainability of their culture. This could cause some additional apprehension about intercultural collaboration within and among national innovation systems. Thus, cultural diversity characterizes both large and small countries, but its impact on innovation systems and processes can be even more prominent in small countries and this is not only positive.

Perry (2001) analyzes the advantage of small economies in terms of creating the shared trust needed for openness and cooperation. This study concludes that based on a comparison of New Zealand and small Nordic economies it is evident that the larger institutional and political structures should be addressed as a precondition for changing business habits toward a more open and trust-based interaction. The focus solely on policy measures that merely support the emergence of cooperation is unlikely to produce sustainable and lasting change without appropriate changes in the wider policy framework, including the innovation system. Shared trust is a cultural issue, which has do be embedded in the societal context more deeply than via

cooperation support alone. Therefore, smallness seems to be necessary, but not a sufficient condition for benefitting from openness and trust.

2.2 Knowledge and Innovative Growth in Small Economies

Griffith (2007) introduces yet another important argument in relation to small economies – knowledge and development potential. Early concepts of development argued that a country's economic structure of production is determined by the natural resources of that country. Because smaller countries tend to have smaller resource reserves than larger countries, they are also likely to have a more concentrated production structure in comparison to larger areas with fewer resource limitations. Griffith (2007) has shown by contrast that economic smallness is not as important a determinant of economic structure as it used to be. The global economy is increasingly integrated and reliant on knowledge skills as perhaps the most important resource in production. Therefore, when small countries are able to accumulate sufficiently appropriate knowledge skills for various industries, they can have a diversified economic structure of production as well. They can offer a wide variety of new products and services, while being able to attract foreign direct investment (Griffith 2007).

These results show that in a knowledge economy, smallness becomes a much more relative issue. Although it might be equally argued that small size and limited financial resources can set limits on knowledge accumulation, there exist several paths for knowledge transfers and spillovers, some of which are expensive and time-consuming, while others are freely available.

Knowledge absorption is also a prominent aspect, as seen in one of the most interesting empirical studies of the relationships between innovation policy choices in a small open economy and welfare and growth by Bye et al. (2009). They use economic modeling to show that the growth and welfare effects of subsidizing innovation are considerably smaller in small open economies than in larger and less-open ones.

Bye et al. (2009) explain this by the fact that a large proportion of the technological development in small economies relies on knowledge absorption from the global knowledge base. Thus, unless the absorptive capacity needed for that depends extensively on domestic R&D and on other domestic policy choices, domestic innovation policies tend to have limited impact on welfare and growth.

Innovation policy does matter, but its design plays an important role in the results. According to Bye et al. (2009), in a small open economy the welfare and growth effects depend on the export opportunities of new technologies. Thus, the policies focused on promoting technological exports could prove to be most efficient. At the same time, supplementary policies should also facilitate technology offerings in the domestic market, in order to deal with market failures and stimulate the variety of productivity potential at home.

Higher R&D intensity and growth might not enhance welfare. The modeling showed that subsidies oriented toward capital formation rather than direct R&D subsidies indeed generate lower R&D intensity and growth. Yet, support for capital formation has a slightly superior impact on welfare in comparison to direct subsidies for R&D. Thus, the impact on growth and the impact on welfare are not the same, and they differ depending on the policy instruments used. This last result is somewhat dependent on the relative strength of inefficiencies in the particular economic setting, but is otherwise robust (ibid.).

In a small open economy, which is reliant on knowledge transfers and spillovers from abroad, there are many other relevant features. Empirical evidence shows how such national efforts as investing in education, domestic knowledge accumulation, international trade relations and FDI-promoting policies can influence the increase in the country's capacity to benefit from global growth in productivity. Such growth strategies are likely to be more efficient in less-developed small open economies, which have relatively weaker R&D institutions and larger knowledge gaps between domestic levels and global technological levels (Bye et al. 2009).

2.3 Small Enterprise Metaphor and System-Policy Interlinks

Davenport and Bibby (1999) use the metaphor of a small enterprise, discussing small economies as small enterprises, to place the national innovation system of small countries within the setting of globalization and localization in the context of the knowledge economy. They argue that most discussions tend to focus on the influence of globalization and localization trends on competitiveness in the large "Triad" of Europe, Japan, and USA. In the knowledge economy, the basis of competitiveness is knowledge, which incorporates skills and capabilities. These can be found in a variety of places including small industrial countries. Thus, Davenport and Bibby (1999) focus on these other nations and their national innovation systems to describe the impact of globalization and localization trends.

They outline the fact that innovation policies in the innovation systems of small countries are being increasingly challenged by the situation where multinational enterprises (MNEs) and localized clusters related to emerging technologies determine technology development paths beyond and across national borders. Small countries that lack a broad technological base, extensive science and technology infrastructure, sufficient resources, and the presence of MNEs face the risk of being marginal players in global competition, especially because of their inability to contribute to such international economic networks. Traditionally, these countries try to counteract to this danger by fighting against the expansive nature of MNEs and the overexploitation of local resources (Davenport and Bibby 1999).

The analysis of globalization and localization drivers in the knowledge economy suggests that the opposite policy attitude should be more suitable for small economies and their national innovation systems. By comparing small countries to small- and

medium-sized enterprises (SMEs), Davenport and Bibby (1999) outline the potential advantages and disadvantages of a small country on the basis of those characteristic to SMEs. Based on the same analogy they propose that a small country innovation strategy should rely on advantages very similar to the advantages enjoyed by SMEs, such as flexibility and the use of external networks to execute outward-looking innovation policies.

These policies should enable rapid communication and flexibility as well as encourage technological accumulation and networking to increase national absorptive and transformative capabilities (ibid.). In short, small countries should act in ways that are very similar to SMEs in order to place themselves within the globalization and localization context dominated by large MNEs and to some extent by large countries. This is done through an innovation policy that depends, however, on the complex influences of several factors.

Hadjimanolis and Dickson (2001) indicate that the development of national innovation policy for a small developing country indeed depends on the specific features of the innovation system of such a country. They outline limited markets, scarce physical resources, shortage of technical skills and reduced bargaining power at the international level as some of the specific features of the small country innovation system. R&D in small developing countries is often dominated by the public sector, while companies are predominantly SMEs and need external innovation support. These smaller enterprises depend on participation in the subcontracting networks of large MNEs. The innovation promotion institutions in small developing countries are likely to be underdeveloped. The main activity within small national innovation systems is often technological diffusion in the form of absorption and adaptation of foreign technology rather than the development of new technologies. The high-tech sectors in a small developing economy tend to be underdeveloped as well. These economies are usually more oriented toward the application of high-tech solutions in existing sectors and not leading edge development of new high-tech solutions.

The policy study by Hadjimanolis and Dickson (2001) using the example of Cyprus showed that cooperation between various promoting institutions was weak and inhibited by conflicting interests. They also noted that the negative attitudes of the owners and managers of private enterprises toward promoting institutions and their policies are at least partially the result of unrealistically high expectations. Despite these weaknesses, they found that the national innovation policy has an important catalytic role by positioning the public sector as the facilitator rather than the provider of innovations.

Hadjimanolis and Dickson (2001) suggest that innovation policy in a small developing country should account in its design for international best practice reflected in the literature and the experiences of more developed industrialized countries, specific conditions related to smallness and under-development that favor orientation toward the diffusion of foreign technologies, and country-specific aspects at the level of enterprises. The overall aim should be an integrated, consistent, and consensual national innovation policy.

2.4 Organizational and Cost Issues in the Small Country Context

The study by Hadjimanolis (2000) outlines organizational characteristics that impact the innovativeness of SMEs in a small country. These include the technological resources available for R&D, organizational capabilities that determine the extent of technological information scanning and strategic planning, and external network capabilities reflected by the extent of cooperation with technology providers. Company size and its overall economic performance are important as well. Somewhat surprisingly, intensity of competition and internationalization in terms of export intensity were shown to be rather weakly related to the innovativeness of small enterprises. Most of the variables that had a strong impact relate to the strategy and are under the control of the enterprises themselves. This suggests that managers have the possibility to facilitate innovativeness by lifting these organizational issues higher in the strategy development agenda. Although the same characteristics might describe larger countries as well, these issues are especially important in the context of relatively weak small national innovation systems.

Jonjic and Traven (2004) point out in their reflection that small economies, in addition to poorer research funding in comparison to larger economies, also suffer from the higher prices of various laboratory supplies. These supplies are often much needed prerequisites for up to date research work. Thus, small countries face important cost limitations on the supply-side. This situation reflects the more general distribution problem in small markets, where distributors tend to inflate margins sky-high in order to compensate for smaller volumes in terms of units sold. In consumer goods sectors this behavior causes an additional burden on households, but in the research sector it is highly detrimental for the entire value chain that needs such imported lab inputs or technological devices.

2.5 Some Sector-Specific Considerations and the Role of Human Capital

The innovation issues in small economies are also outlined by sector-specific studies. These studies tend to focus on case evidence, which cannot be easily used to generalize for all small countries. Therefore, the following studies serve an illustrative purpose and intend to show through biotechnology what sector-specific factors may influence small national innovation systems.

Calvert and Senker (2004) offer a comparative study of innovation problems in the biotechnology sectors of Portugal and Ireland. They take an innovation system perspective and try to clarify the differences in innovation performance between these two countries. The results show that there are specific system failures to be considered. The comparison showed that Portugal is not as successful in providing biotechnological innovations as Ireland. The causes of this gap in performance could at least partially be attributed to insufficient industrial demand for biotechnological

solutions in Portugal. Innovative performance suffers from the lack of demand by incumbent companies to employ biotechnology graduates in order to undertake in-house research or from the lack of demand for scientific knowledge in biotechnology produced by the public sector. The authors conclude that improved balance and stability is needed in the particular innovation system in order to stimulate growth. They recommend using an integrated set of innovation policies that would address both, the development of the knowledge base and the commercialization efforts on the demand-side for the promotion of biotechnology in a small country.

O'Neill (2007) provides an overview of perspectives in the Estonian biotechnology sector. He argues that the small size in this case seems to facilitate the drive to be outward looking. Where Estonian biotechnology scientists lack experience, expertise or critical mass they go seeking collaborations and joining scientific consortia in order to gain access to international expertise. The young scientists often have conducted post-doctoral studies in various labs in Scandinavia or North America.

In terms of network building, the Estonian biotechnology sector clearly lacks good access to major pharmaceutical companies, while it needs the commercial expertise of such companies in order to establish market links. There are several cooperative initiatives in the Estonian biotechnology sector that seek to overcome the limitations by pooling life sciences and biotechnology resources in universities with start-ups and biopharmaceutical companies across a wider region covering Scandinavia, the Baltic States and regions from Germany and Russia (O'Neill 2007).

The future of the Estonian biotechnology sector depends on the general development path of the global biotechnology sector. According to O'Neill (2007), one possible scenario is that all major activities will be concentrated in a few global hubs, where science, funding possibilities, and enterprises are all located within well-defined geographical areas. This scenario might be detrimental for biotechnology growth in Estonia. Another scenario is that biotechnology becomes a diffuse global enterprise with a democratic element, which suggests that good science can be done by scientists anywhere. Within this scenario smaller countries like Estonia have better prospects for offering considerable scientific and commercial contributions.

Moreno et al. (2008) investigate the use of computational biology – a branch of bioinformatics – in Costa Rica, which has population around 4.5 million people. They also conclude that an integrated effort is needed, which requires a significant strengthening of the local scientific community, the consolidation of research groups that have developed a critical mass of scientists and expertise, and the facilitation of interactions between local groups and the international scientific communities. There is a place for small scientific communities in the global efforts to understand and use global biodiversity.

These results in the bio-sector reinforce the idea that on the level of various sectors, small economies have the potential to contribute mainly through international knowledge exchange and collaboration. This offers further support for the argument that small country innovation systems can compensate for scarce material resources by creating advanced knowledge resources. However, these resources gain more value through collaborations in the international networks and potentially lose value by remaining peripheral due to location-related disadvantages.

The collaborative potential of young scientists from small countries is highlighted by an editorial comment from Frischknecht (2008), which shows somewhat surprisingly that small countries are more successful at obtaining research grants from the European Research Council (ERC). This suggests that the shortage of natural resources is indeed to some extent substituted with human capital.

The formation of human capital and economic performance in a small economy are analyzed in detail by Heijdra and Romp (2009). They find that the engine of growth during demographic transition is an intergenerational externality in the production of human capital, where the reduction in fertility has a strong effect. This indicates that in small economies, demographic parental support measures are likely to have an indirect but strong long-term effect on human capital formation and subsequently on innovation. In this light, the continuation of generations in science has potentially considerable links with the general demographics in a small country.

2.6 Networking, Clusters, and FDI in Small Country Innovation Systems

Chen and Guan (2010) analyze the impact of small world networks on innovation outputs. Small world networks refer to networks with high local clustering, while the average number of intermediates needed to connect any actors is relatively small. This short path can bring fresh and nonredundant information from distant ties, and inspire new ideas and creativity. Such networks have received attention in several research fields. They are argued to have advantages in information diffusion, creativity achievements, trust, learning, and collaboration. Small world networks do indeed improve innovation performance. Small world networks and small economies are not the same, but smallness creates favorable spatial conditions for the emergence of such networks perhaps even at the national or supra-national regional level.

Indeed, Pitelis (2009) argues that FDI and clusters can contribute to a country's competitiveness, especially when aligned with the advantages and selected competitive positioning of the country. Small countries have some advantages in implementing foreign investment and clustering strategies. They can use these advantages to achieve competitiveness and catching-up, provided that they can successfully deal with the liabilities of smallness, like corruption. Small transition economies, which are not landlocked in distant locations, are the most suitable candidates for the use of such strategies. Tiits (2007) argues in a similar fashion that the use of a proactive foreign investment strategy is an effective method for a small country to increase the knowledge intensity of its economy. Yet, in Estonia, like many other small EU Member States, the innovation policy underestimates the role of such strategies. This calls for more focused foreign direct investment support initiatives and their closer coordination with education, research, and employment policies.

The more general comparative view offered by van Beers (2004) evaluates the role of FDI more critically. By comparing the paths to a knowledge economy in three small countries – Finland, Ireland, and the Netherlands, the author aims to gain some lessons from the first two cases for the Dutch innovation policy.

He concludes that the Irish model, which is based on incoming FDI, might not be sustainable in the case of fiscal reduction. The Finnish model seems to be more attractive and sustainable because of its commitment to the quality of the national innovation system. In this system more elaborate cooperation than just financial investments between firms (including foreign firms) and public knowledge institutions is encouraged. Therefore, van Beers (2004) concludes that in addition to inward FDI, investments into the development of the national innovation system are needed in order to attract the R&D facilities of multinationals seeking to benefit from domestic knowledge, while domestic institutions gain access to new technological developments needed by the markets. Thus, small economies have potential foreign investment, clustering and networking advantages, which are often underestimated and somewhat discarded or misused by their policy makers.

2.7 Problems in Policy Determination: The Example of Luxembourg

The innovation policies implemented within the national innovation system of a small country can be determined in various ways. Glod et al. (2009) describe the experience of using Foresight Exercise for determining science and technology priorities for Luxembourg, which is one of the wealthiest small countries in the world. Priority setting is more crucial in small systems due to the inherent constraints and limitations discussed in previous sections. The process that lasted from 2006 to 2007 included several phases. The first of them was related to defining the current position of the country against the research context of international trends in various research priorities in order to identify possible research tracks for Luxembourg. The second phase set out to formulate broader research themes, which would outline priorities for research funding. The authors conclude that the set of themes developed served the funding schemes of the public support foundation too much, which also had an active role during the entire process. In other words, the outcome was perhaps too focused and the list of themes too long, a list which had to be revised in order to articulate more general national priorities.

The other mistake made during the Foresight Exercise relates to the focus on theme setting alone. The analysis showed that the structure of support initiatives should have been revised in parallel. The role of the exercise in terms of outlining new domains of research remained somewhat unclear as well. Certain problems also concerned the criteria of prioritization used during the process. Although, in general the criteria followed international practice, the process was limited by the lack of vision about the particular role for science and technology in the general development of Luxembourg, as well as by the lack of sufficient and appropriate national data about some aspects. The discussions about who should be involved in the priority setting process created additional tension. All in all the leading institutional role of the main support organization had both advantages and drawbacks Glod et al. (2009).

This priority setting exercise enables us to draw some important implications for other small countries that intend to refine their innovation policies in terms of

enhanced priorities in the context of international developments. Despite the drawbacks outlined, the general process itself was considered successful. Thus, similar evaluation and adjustment procedures could be applicable in many other small countries. Large countries can benefit from such exercises as well, but their resources allow greater tolerance of less efficient procedures.

Meyer (2008) offers an even more extensive overview of the scientific landscape in Luxembourg, which is indeed one of the smallest countries in Europe. In addition to the Foresight Exercise, this study focused on professional aspects or research work, and on diversification and cooperation between the actors. The results indicated that innovation cooperation and collaboration in small country systems is not necessarily better than in a larger setting. This means that smallness indicates potential for efficient collaboration, but realizing this calls for well-targeted efforts.

2.8 The General Features of Small-Scale Innovation Systems

One description of features that are characteristic of small country innovation systems was already offered above by Hadjimanolis and Dickson (2001) in connection to the analysis of system and policy interlinks. These features included limited markets, scarce physical resources, shortage of technical skills, and reduced bargaining power at the international level. They also outline that R&D in small developing countries is often dominated by the public sector. Business in small countries is usually dominated by SMEs that depend on participating in the subcontracting networks of large MNEs. The small national innovation systems are often predominantly oriented toward technological diffusion in the form of the absorption and adaptation of foreign technology.

In addition to this view, Meyer (2008) argues that in comparison to larger countries, smaller ones tend to share three specific characteristics. Small countries have a less developed and mature research infrastructure and science policy, a shorter distance between researchers and science policy, and an eminent need to import knowledge and expertise.

Further comparison with the experiences of national innovation systems (especially in Singapore and Ireland) and the various results discussed above allow us to draw the following important conclusions about the specific nature of small-scale innovation systems (based on the analysis above and loosely also on Wong and Singh 2008; O'Malley et al. 2008):

1. Small-scale innovation systems face considerable regional and cultural disparities along with adverse cost levels for inputs and organizational challenges at the company level. These disparities can even have a larger influence on innovations than they do in a larger country.
2. The small-scale national innovation systems are relatively more dependent on the inflow of FDI because local levels of investment capital are insufficient.
3. The rapid development of small economies and their subsequent innovation systems is at least initially based predominantly on inward transfers of knowledge and technologies.

4. Small-scale national innovation systems require well-developed policy schemes and integrated efforts in order to enhance the development of domestic R&D activities, innovations, and entrepreneurship.
5. International cooperation and foreign openness along with enhanced cross-border network ties beyond FDI and knowledge inflows are essential substitutes for the restricted capabilities of domestic support.
6. The success of small-scale national innovation systems is inherently more dependent on using limited resources and capabilities for well-defined and focused innovation activities than that of larger systems. Thus, priority setting procedures are likely to have crucial importance.
7. Small-scale national innovation systems should build predominantly on human and social capital in order to cope with inherent financial constraints.
8. Small-scale national innovation systems offer flexible policy adjustment opportunities, but they could be reduced by inefficient collaboration and by disagreements concerning goal setting.

The list above combines the meta-synthesis of previous sections with the experiences of two small countries – Singapore and Ireland. Despite this approach, it is possible that certain features are somewhat under-represented. However, in the context of this monograph, this is sufficient for making a distinction between small and large national innovation systems.

2.9 Concluding Remarks

Small countries are not uniform and homogeneous in their development pattern or commitment to innovation. Some smaller economies, for example Finland, belong to the innovation leaders of the world, while others are underdeveloped and poor. Because of this diversity, it is difficult to determine the set of characteristics that would equally well describe all small economies and their small-scale national innovation systems. However, even the fragmented research evidence that is available allows us to outline the major commonalities of small systems. These include the higher importance of inward FDI and knowledge flows, well-integrated actions and policy schemes, extensive international collaboration and cluster membership, clear development focus, human and social capital, and higher flexibility than in larger systems. Although these aspects are relevant for large countries as well, they are more critical for success in small economies. When a small economy succeeds in drawing extensively on these compensatory measures, it is indeed possible to reach a highly competitive level in the setting of the new knowledge economy. Small economies can be metaphorically compared to small enterprises, which succeed through focused collaboration in international networks and by using niche strategies.

Inward transfers of capital, technologies, and knowledge might not secure sustainable development opportunities for a small economy because such flows tend to be fluctuating and cyclical. Therefore, small countries need to invest time and effort into building elaborate national and international collaborative systems that enable

complex adjustments and support longevity. The ability to do so might be limited due to disagreements between the actors and due to differing views on the aims of the innovation system. Thus, small countries need to choose and follow generally accepted paths.

Acknowledgments This study has been prepared with financial support received from the Estonian Science Foundation (Grants 7405, 8546 and 8580) and from the Estonian Ministry of Education and Research (Target Financing SF0180037s08).

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http://www.springer.com/978-1-4614-1547-3

Innovation Systems in Small Catching-Up Economies
New Perspectives on Practice and Policy
Carayannis, E.G.; Varblane, U.; Roolaht, T. (Eds.)
2012, XXXII, 396 p., Hardcover
ISBN: 978-1-4614-1547-3